



Northwest Fisheries Science Center

National Marine Fisheries Service

U.S. DEPARTMENT OF COMMERCE

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Results of the 2008 Pacific Hake Inter-Vessel
Calibration off the West Coast of Vancouver Island,
Canada Aboard the NOAA Ships *Miller Freeman*
and *Oscar Dyson* and the CCGS *W.E. Ricker*

December 2010

Cruise Period, Area, and Schedule

Scientists from the U.S. Northwest Fisheries Science Center (NWFSC) and the Science Branch of the Department of Fisheries and Oceans (DFO), Canada, conducted an Inter-Vessel Calibration (IVC) on Pacific hake (*Merluccius productus*) along the west coast of Vancouver Island, Canada between the NOAA ships *Miller Freeman* and *Oscar Dyson*. The CCGS *W.E. Ricker* also participated in the IVC. However, due to a malfunction of acoustic equipment on the *W.E. Ricker*, an IVC was not conducted between the NOAA Ships and the *W.E. Ricker*. The *W.E. Ricker* contributed to the IVC by conducting fishing operations and by measuring oceanographic conditions with deployment of conductivity-temperature-depth (CTD) casts and bongo nets.

The cruise of the U.S. team began and ended in Seattle, Washington and ran from August 10 to August 29, 2008. It covered an area off the west coast of Vancouver Island, focusing on Pacific hake aggregations near Barkley Sound/La Perouse Bank, Nootka Sound, and Kyoquot Sound.

The cruise included two legs and the vessels' itinerary was as follows:

Leg 1

- | | |
|--------------|---|
| August 10-11 | Embark scientific party in Seattle, Washington. Conduct an acoustic system calibration with standard targets on the <i>Miller Freeman</i> and <i>Oscar Dyson</i> in Elliott Bay. |
| August 11-12 | Transit north to La Perouse Bank area to start IVC and scout for Pacific hake. |
| August 13-15 | Continue IVC scouting for Pacific hake on La Perouse Bank. The <i>Oscar Dyson</i> completes its portion of La Perouse Bank scouting and begins transit north to Kyoquot Sound on August 14. The <i>Miller Freeman</i> completes scouting at La Perouse Bank, leaving August 15 to join the <i>Oscar Dyson</i> near Kyoquot Sound. |
| August 16-17 | Begin side-by-side and follow-the-leader portion of IVC between the <i>Miller Freeman</i> and <i>Oscar Dyson</i> near Kyoquot Sound. |
| August 18-19 | Transit to Port Angeles, Washington for crew change and one-day inport. |

Leg 2

- | | |
|-----------|---|
| August 20 | Depart Port Angeles for Mayne Bay, Barkley Sound, British Columbia. The <i>W.E. Ricker</i> joins the IVC. |
| August 21 | Conduct an acoustic system calibration with standard targets on the <i>Miller Freeman</i> , <i>Oscar Dyson</i> , and <i>W.E. Ricker</i> in Mayne Bay, British Columbia. Transit north to Kyoquot Sound after the calibration. |

- August 22-25 The *Miller Freeman* and *Oscar Dyson* continue side-by-side and follow-the-leader portions of the IVC near Kyoquot Sound. The *W.E. Ricker* begins fishing operations and deploying CTD casts and bongo nets.
- August 26-28 The *Miller Freeman* develops mechanical problems and returns to Seattle after an overnight stop at Port Angeles. The *Oscar Dyson* returns to La Perouse Bank.
- August 29 The *Oscar Dyson* transits to Seattle. End of cruise.

Objectives

The primary goal of the 2008 Hake Inter-Vessel Calibration was to determine if there were differences in acoustic measurements between the current survey vessel, the NOAA Ship *Miller Freeman*, and one of the new class of Fishery Survey Vessel (FSV), the NOAA Ship *Oscar Dyson*. The IVC is a crucial component of continuing the long-term time series of Pacific hake Integrated Acoustic and Trawl (IAT) surveys, one that allows for the direct comparison of data that were collected historically to data that will be collected when the newest FSV, the NOAA Ship *Bell M. Shimada*, enters service in 2010. The 2008 IVC also had a number of secondary objectives, including: 1) to calibrate the 18-kHz, 38-kHz, 70-kHz, 120-kHz, and 200-kHz scientific acoustic systems using standard sphere techniques; 2) to test a new automated calibration system; 3) to collect target strength measurements of Pacific hake; 4) to collect physical oceanographic data (temperature and/or salinity profiles) at selected sites, continuous sea surface temperature and salinity, and bongo net hauls; 5) to collect stomach samples from Pacific hake for food habits studies; 6) to test a new, net-mounted, open-codend camera system; and 7) to collect Video Plankton Recorder (VPR) data.

Methods

Sampling Equipment

Acoustic data were collected with the Simrad EK60 scientific echo sounder system using the ER60 software system on board the NOAA Ships *Miller Freeman* and *Oscar Dyson*. The two ships are stern trawlers equipped for fisheries and oceanographic research. Simrad 18-kHz, 38-kHz, 120-kHz, and 200-kHz split-beam transducers were mounted on the bottom of retractable centerboards which, when fully extended, held the transducers 9.15 m below the water surface (the *Oscar Dyson* also had a 70-kHz split-beam transducer mounted on the centerboard). Raw acoustic backscatter (EK 60) and Echolog 500 data files (EK500 data format) were logged; the latter were used for live viewing in SonarData Echoview. Event log markers and other marks, including initial judgments of Pacific hake backscattering layers, were made on the live-viewed files.

Pelagic trawling on the *Miller Freeman* was performed with an Aleutian wing trawl 24/20 (AWT). This net had a vertical opening that averaged 24 m (range = 19–27 m), a headrope and

footrope of 101.8 m each, and a total length of 128 m. Mesh sizes tapered from 320.0 cm in the forward section of the net to 10.0 cm in the codend; a 3.2-cm codend liner was used. The AWT was deployed with a pair of 4-m² 'Fishbuster' trawl doors (884.5 kg), 82.3-m legs, and 226.8-kg or 113.4-kg chain ("Tom") weights on each side. Trawling on bottom was performed with a poly Nor'eastern trawl 89/121 (PNE). This net had a vertical opening that averaged 7 m (range = 58 m), a headrope of 27.1 m, a footrope of 36.6 m, and a total length of 42.1 m. Mesh size was 12.7 cm in the intermediate section and a 3.2-cm codend liner was used. The PNE also used the 4-m² 'Fishbuster' trawl doors. A WESMAR TCS 770 third-wire scanning sonar system for the trawl headrope or Furuno wireless net sounder system was used to monitor and guide the fishing process for all tows.

An AWT was also used on the *Oscar Dyson*, but this net had been modified with a baffle to direct fish past a video camera system mounted inside the net. There were two 10-cm laser length references to measure fish length, and the net was fished with the codend open. Use of this net marked the first time that Acoustics Team scientists from the NWFSC tested a non-extractive video camera system for identifying fish. A Simrad FS-70 third-wire scanning sonar system was used on the trawl headrope.

Vertical profiles of temperature and salinity data were collected with a Sea-Bird Electronics, Inc. SBE 911*plus* conductivity-temperature-depth (CTD) system during calibrations of the acoustic system and at locations along designated acoustic transects. CTD casts were conducted at night after collection of acoustic data had ceased. CTD data provide necessary oceanographic data in the survey region and can be used to obtain a sound speed profile. To obtain high-resolution optical images of plankton in the water column, a SeaScan, Inc. video plankton recorder (VPR) was mounted on the CTD rosette and deployed with CTD casts on the *Miller Freeman*. Additional temperature and depth profile data were collected by attaching a Sea-Bird SBE 39 temperature/pressure sensor to the trawl headrope during trawl hauls. Ocean current velocity profile data were obtained using a Teledyne RD Instruments Ocean Surveyor 75-kHz Acoustic Doppler Current Profiler (ADCP) system. Sea surface temperature and salinity data were collected and stored on the *Miller Freeman's* Scientific Computing System (SCS).

Inter-Vessel Calibration Methods

The west coast of Vancouver Island was selected as the study area due to historical data showing hake aggregations present on the La Perouse Bank during the month of August. The IVC differed in transect length, depth range, and spacing from a traditional Pacific hake integrated acoustic and trawl (IAT) survey. In addition, transects were run as a zigzag pattern rather than traditional parallel transects in order to maximize time spent over fish during this short research cruise.

Vessel speed was maintained at 5.6-6.1 m/sec (11-12 knots) during acoustic sounding along each transect. Acoustic operations were run only between sunrise and sunset (i.e., roughly from 0600 to 2100 PDT, about 15 hours per day) when Pacific hake formed distinct and identifiable midwater layers. Physical oceanographic data were recorded during both day and night.

Trawl samples and video data (codend video camera) were collected to provide ground truthing for classifying observed backscatter layers to species, for Pacific hake size composition, and to collect specimens of Pacific hake and other organisms. The number and locations of trawl sets were not pre-determined—other than an allowance for an expected total number of tows based on time constraints of the cruise—but were dependent on the occurrence and pattern of backscattering layers observed at the time of the cruise. Coverage by trawling was not systematic, but adaptive, and individual tows did not require a standardized effort. Distinct layers of intense backscatter that were indicative of high densities of Pacific hake were the highest priority for trawl sample assignments. The AWT camera system allowed us to tow through and classify multiple layers with one tow. Trawl duration was kept to the minimum necessary to ensure an adequate sample. Average trawling speed was about 1.5 m/s (3 knots).

All trawl catches were sorted completely. Total numbers and weights were determined for all species, although invertebrates that are not efficiently caught by a trawl (e.g., jellyfish, salps, and euphausiids) could not always be counted. Aggregate weights were measured to the nearest 0.05 kg for the sorted portions of the catch using an electronic, 60-kg capacity Marel M60 motion-compensated scale. Pacific hake were subsampled to determine length composition by sex, to collect otoliths for subsequent age determination, and to collect individual weight measurements and gonad condition. Pacific hake were sampled completely from a trawl catch when just a small number were caught, i.e., fewer than roughly 300 to 400. Fish lengths (fork length) were determined to the nearest centimeter using a Scantrol FM100 FishMeter board. An electronic, 15-kg capacity Marel M1100 motion-compensated scale was used to determine all weights of individual fish specimens to the nearest 0.02 kg. Pacific hake maturity was determined by visual inspection of gonads and classified by a 5-stage scale (ADP Code Book, 2007, RACE Division, AFSC, Seattle, Washington). Otoliths were preserved in 50% ethanol for subsequent age determination. Pacific hake stomachs (or those of other species collected) were collected and preserved in 10% neutral-buffered formalin.

Preliminary Results

Two calibrations of the *Miller Freeman* and *Oscar Dyson* acoustic systems were conducted (Table 1): the first on 10 and 11 August in Elliott Bay, Washington, and the second on 21 August in Mayne Bay, British Columbia. Results of the two calibrations for the 38-kHz system of both vessels were within expected levels based on factory settings and results from previous calibrations. However, results for the other frequencies were outside accepted tolerance levels. Thus, system settings used during the 2008 IVC were obtained from acoustic calibrations conducted during June–July 2008 on the *Miller Freeman* and *Oscar Dyson* by scientists from the Alaska Fisheries Science Center.

The observed distribution of Pacific hake in 2008 was not that of a typical year and finding suitable aggregations of Pacific hake was challenging. While conducting the IVC, the *Miller Freeman* ran a total vessel track line of approximately 4,325 km (2,335 nmi) and the *Oscar Dyson* ran 4,630 km (2,500 nmi). The *Miller Freeman* and *Oscar Dyson* ran approximately 432 km (233 nmi) of follow-the-leader transects and approximately 356 km (192 nmi) of side-by-side transects during leg 1 (Figure 1) and leg 2 (Figures 2 and 3) of the cruise.

A total of 33 trawls were successfully conducted by the three vessels: 7 trawls on the *Miller Freeman* (Table 2, Figure 4), 9 camera trawls on the *Oscar Dyson* (Table 3, Figure 4), and 17 trawls on the *W.E. Ricker* (Figure 4). Catch weights on the *Miller Freeman* ranged from 48.6 kg to 3,148.4 kg (mean = 958.6 kg). Camera trawls on the *Oscar Dyson* mostly observed Pacific hake, but also Pacific ocean perch (*Sebastes alutus*), lanternfish, squid, yellowtail rockfish (*Sebastes flavidus*), and krill and shrimp. Midwater trawls conducted aboard the *Miller Freeman* caught predominantly Pacific hake (~87% by weight), with some Pacific ocean perch and yellowtail rockfish (Table 4). Bottom trawls caught a more evenly distributed mix of species (Table 5), with the top five species (by weight) being yellowtail rockfish, Pacific hake, Dover sole (*Microstomus pacificus*), rougheye rockfish (*Sebastes aleutianus*), and sablefish (*Anoplopoma fimbria*). During the cruise, biological sampling of Pacific hake included 818 length measurements and 376 collected pairs of otoliths (Table 6). The overall length-frequency distribution of Pacific hake measured during the cruise displayed a unimodal distribution (Figure 5) with an average fork length of about 49 cm, which correlated with adult Pacific hake four years old and greater.

Twenty-three CTD temperature and salinity profiles were collected on the *Miller Freeman* (Table 7, Figure 6) and thirteen were collected on the *Oscar Dyson* (Table 8, Figure 6) at selected locations. Additional temperature profiles were collected from eight SBE casts that were collected at *Miller Freeman* trawl stations. Analysis of oceanographic data is ongoing.

The visual, at-sea comparison of hake aggregation looks promising, and the aggregations appear similar between the vessels as detected by the acoustics systems. Quantitative analysis of acoustic data is in process. Trawl results were similar between the traditional hauls conducted on the *Miller Freeman* and *W.E. Ricker*, and the video obtained by the camera tows conducted on the *Oscar Dyson*. Data must be verified and analyzed prior to release. Data from this project will be shared among the participants, NOAA and DFO. NOAA scientists are responsible for data analysis of the IVC.

Scientific Personnel

<u>Name</u>	<u>Sex/Nationality</u>	<u>Position</u>	<u>Organization</u>
<u>Leg 1 Miller Freeman</u>			
Dezhang Chu	M/USA	Chief Scientist	NWFSC
Julia Clemons	F/USA	Fish. Biologist	NWFSC
Ken Cooke	M/Canada	Acoustician	DFO (8/12–8/15)
Stephen de Blois	M/USA	Acoustician	NWFSC
Melanie Johnson	F/USA	Fish. Biologist	NWFSC
Jennifer Sindelier	F/USA	Marine Engineer	Teledyne RDI

		<u>Leg 1 <i>Oscar Dyson</i></u>	
Larry Hufnagle	M/USA	Chief Scientist	NWFSC
Lisa Bonacci	F/USA	Acoustician	NWFSC
Waldo Wakefield	M/USA	Fish. Biologist	NWFSC

		<u>Leg 2 <i>Miller Freeman</i></u>	
Dezhang Chu	M/USA	Chief Scientist	NWFSC (8/20–8/26)
Stephen de Blois	M/USA	Acoustician	NWFSC
Candice Emmons	F/USA	Fish. Biologist	NWFSC
Chris Grandin	M/Canada	Acoustician	DFO (8/25–8/26)
Melanie Johnson	F/USA	Fish. Biologist	NWFSC
Al Young	M/Canada	Fishing Master	CCG (8/20–8/25)

		<u>Leg 2 <i>Oscar Dyson</i></u>	
Lisa Bonacci	F/USA	Chief Scientist	NWFSC
Dezhang Chu	M/USA	Acoustician	NWFSC (8/26–8/29)
Larry Hufnagle	M/USA	Acoustician	NWFSC
Jennifer Nield	F/Canada	Fish. Biologist	DFO (8/20–8/25)
Al Young	M/Canada	Fishing Master	CCG (8/25–8/26)

CCG – Canadian Coast Guard

DFO – Department of Fisheries and Oceans Canada, Nanaimo, British Columbia

NWFSC – Northwest Fisheries Science Center, Seattle, Washington

Teledyne RDI – Teledyne RD Instruments, Poway, California

Table 1. Simrad ER60 38-kHz acoustic system descriptions and settings used during the 2008 inter-vessel calibration (IVC) on Pacific hake along the west coast of Vancouver Island, Canada, and results from acoustic system calibrations with standard targets conducted during the survey. SV denotes volume backscattering and TS denotes target strength.

	Survey system settings		Calibrations			
			10 Aug	11 Aug	21 Aug	21 Aug
			Elliott Bay, Washington		Mayne Bay, British Columbia	
	<i>Oscar</i>	<i>Miller</i>	<i>Oscar</i>	<i>Miller</i>	<i>Oscar</i>	<i>Miller</i>
	<i>Dyson</i>	<i>Freeman</i>	<i>Dyson</i>	<i>Freeman</i>	<i>Dyson</i>	<i>Freeman</i>
Transducer:	ES38B	ES38B	ES38B	ES38B	ES38B	ES38B
Transducer depth (m):	9.15	9.15	9.15	9.15	9.15	9.15
Pulse length (ms):	1.024	1.024	1.024	1.024	1.024	1.024
Transmitted power (W):	2,000	2,000	2,000	2,000	2,000	2,000
Angle sensitivity						
Along:	22.76	23.77	21.90	21.90	22.76	23.77
Athwart:	21.37	23.83	21.90	21.90	21.37	23.83
Two-way beam angle (dB):	-20.74	-21.09	-20.70	-21.00	-20.74	-21.09
Sa correction (dB):	-0.60	-0.57	-0.97	-0.60	-0.75	-0.74
S _v gain (dB):	22.30	25.63	22.11	25.59	21.79	25.42
TS Gain (dB):	22.90	26.20	23.09	26.20	22.54	26.09
3-dB beamwidth (deg.)						
Along:	6.77	6.46	6.80	6.80	6.77	6.46
Athwart:	7.25	6.42	7.20	6.90	7.25	6.42
Angle offset (deg.)						
Along:	-0.06	0.05	0.00	0.00	-0.09	-0.01
Athwart:	-0.09	-0.01	0.00	0.00	-0.06	-0.05
Post-processing S _v threshold (dB):	-69	-69	-69	-69	-69	-69
Sphere range from transducer (m):	--	--	20.0	24.36	24.00	23.0
Absorption coefficient (dB/m):	0.009855	0.009855	0.009855	0.009855	0.009855	0.009855
Sound velocity (m/s):	1480.6	1480.6	1494.89	1492.71	1489.6	1496.2
Ambient water temperature* (°C):	--	--	12.5	12.8	13.1	12.8
Salinity (ppt)	--	--	29.54	29.7	31.97	31.36

*measured at face of transducer

Table 2. Trawl station and catch data summary from the NOAA Ship *Miller Freeman* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

Haul no.	Date	Time (PDT)	Duration (min.) ^a	Gear type ^b	Start position		Depth (m)		Temp. (°C)		Catch		
					Latitude	Longitude	Gear ^c	Bottom	Gear ^d	Surface	Pacific hake (kg)	Number	Other (kg)
1	13 Aug	19:22	3	AWT	haul unsuccessful		169	201	6.90	15.18	--	--	0.3
2	14 Aug	9:36	30	PNE	48 45.01	126 19.74	311	381	6.51	14.14	20.6	26	2.0
3	14 Aug	20:17	15	PNE	48 55.25	126 16.42	126	132	6.83	14.40	--	--	313.4
4	15 Aug	18:56	20	PNE	49 0.80	126 50.45	414	414	5.86	13.81	91.8	129.0	321.6
5	16 Aug	13:05	--	AWT	haul unsuccessful		--	--	--	12.91	--	--	--
6	16 Aug	14:45	10	AWT	49 44.04	127 31.17	338	349	5.94	13.10	897.7	1,076	14.4
7	17 Aug	13:26	12	AWT	49 46.33	127 40.33	319	589	6.13	12.61	78.7	107	52.3
8	22 Aug	13:40	29	AWT	49 42.91	127 29.58	228	350	6.85	13.98	73.0	94	264.6
9	23 Aug	9:04	7	AWT	49 35.20	127 20.20	294	518	6.74	12.63	1,429.9	1,685	33.6

^a Duration is the time during trawling between "Target Depth" and "Haul Back."

^b AWT = Aleutian wing midwater trawl, PNE = poly Nor'eastern bottom trawl

^c Gear depths were measured at the foot rope.

^d Gear temperatures were measured at the head rope.

Table 3. Camera trawl station summary from the NOAA Ship *Oscar Dyson* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

Haul no.	Date	Time (PDT)	Duration (min.) ^a	Start position		Bottom Depth (m)	Surface Temp. (°C)	Species observed
				Latitude	Longitude			
1	13 Aug	12:56	6	48 40.53	125 43.63	141	13.69	camera misaligned
2	14 Aug	10:46	26	49 0.17	126 44.38	274	14.55	Pacific ocean perch (POP) and hake
3	14 Aug	21:18	43	49 10.41	127 10.03	1,285	15.14	lanternfish & a few squid
4	15 Aug	12:25	--	49 47.91	127 42.87	604	13.61	missed target sign
5	15 Aug	15:13	41	49 47.12	127 40.82	496	14.05	hake & lanternfish
6	16 Aug	13:23	34	49 42.89	127 31.37	385	13.33	hake & many lanternfish
7	17 Aug	14:12	10	49 46.34	127 39.92	478	12.99	~90% hake, 10% POP, & squid
8	22 Aug	14:15	41	49 43.47	127 30.04	>300	14.23	hake with a few POP, squid, & lanternfish
9	23 Aug	9:30	47	49 35.77	127 19.98	428	12.84	hake, POP, yellowtail rockfish, lanternfish
10	26 Aug	12:56	28	49 15.35	127 7.83	651	14.53	primarily lanternfish, but also krill & shrimp
11	27 Aug	16:13	4	48 34.96	126 9.58	306	14.10	none

^a Duration is the time during trawling between "Target Depth" and "Haul Back."

Table 4. Catch by species from Aleutian wing (AWT) midwater trawl hauls conducted aboard the NOAA Ship *Miller Freeman* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

Common name	Scientific name	Weight (kg)	(%)	Numbers
Pacific hake	<i>Merluccius productus</i>	2,479.2	87.2	2,962
Pacific ocean perch	<i>Sebastes alutus</i>	223.9	7.9	183
yellowtail rockfish	<i>Sebastes flavidus</i>	107.6	3.8	68
bocaccio	<i>Sebastes paucispinis</i>	9.5	0.3	3
Pacific halibut	<i>Hippoglossus stenolepis</i>	8.6	0.3	1
silvergray rockfish	<i>Sebastes brevispinis</i>	6.0	0.2	3
canary rockfish	<i>Sebastes pinniger</i>	4.8	0.2	2
blackgill rockfish	<i>Sebastes melanostomus</i>	1.5	0.1	1
roughey rockfish	<i>Sebastes aleutianus</i>	1.2	<0.1	1
lanternfish	Myctophidae	1.0	<0.1	152
barracudina	Paralepididae	0.5	<0.1	1
euphausiid	Euphausiacea	0.3	<0.1	--
salps	Thaliacea	0.1	<0.1	4
jellyfish	Scyphozoa	0.1	<0.1	--
glass shrimp	<i>Pasiphaea pacifica</i>	0.1	<0.1	25
squid	Teuthida	0.1	<0.1	7
blackbelly dragonfish	<i>Stomias atriventer</i>	<0.1	<0.1	1
Pacific viperfish	<i>Chauliodus macouni</i>	<0.1	<0.1	1
sergestid shrimp	Sergestidae	<0.1	<0.1	2
shrimp	Decapoda	<0.1	<0.1	1
--	<i>Taonius pavo</i>	<0.1	<0.1	1

Table 5. Catch by species from poly Nor'eastern (PNE) bottom trawl hauls conducted aboard the NOAA Ship *Miller Freeman* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

Common name	Scientific name	Weight (kg)	(%)	Numbers
yellowtail rockfish	<i>Sebastes flavidus</i>	306.5	40.9	275
Pacific hake	<i>Merluccius productus</i>	112.4	15.0	155
Dover sole	<i>Microstomus pacificus</i>	111.5	14.9	228
rougeye rockfish	<i>Sebastes aleutianus</i>	65.9	8.8	42
sablefish	<i>Anoplopoma fimbria</i>	45.2	6.0	23
unsorted shab	--	26.6	3.5	--
Pacific ocean perch	<i>Sebastes alutus</i>	21.8	2.9	31
shortspine thornyhead	<i>Sebastolobus alascanus</i>	20.3	2.7	104
longnose skate	<i>Raja rhina</i>	11.6	1.5	2
blackgill rockfish	<i>Sebastes melanostomus</i>	11.2	1.5	3
spiny dogfish	<i>Squalus acanthias</i>	3.8	0.5	1
redbanded rockfish	<i>Sebastes babcocki</i>	3.5	0.5	1
arrowtooth flounder	<i>Atheresthes stomias</i>	3.2	0.4	3
sandpaper skate	<i>Bathyraja kincaidii</i>	3.0	0.4	3
aurora rockfish	<i>Sebastes aurora</i>	1.6	0.2	3
rex sole	<i>Glyptocephalus zachirus</i>	0.5	0.1	2
giant soft sea cucumber	<i>Parastichopus leukothele</i>	0.2	<0.1	1
eulachon	<i>Thaleichthys pacificus</i>	0.2	<0.1	3
shrimp	Decapoda	0.1	<0.1	35
chinook salmon	<i>Oncorhynchus tshawytscha</i>	0.1	<0.1	1
salps	Thaliacea	0.1	<0.1	3
fragile red sea urchin	<i>Allocentrotus fragilis</i>	0.1	<0.1	1
slender sole	<i>Lyopsetta exilis</i>	0.1	<0.1	2
lampfish	<i>Lampanyctus</i> sp.	0.1	<0.1	1
sculpin	Cottidae	0.1	<0.1	1
squid	Teuthida	<0.1	<0.1	2
lanternfish	Myctophidae	<0.1	<0.1	1

Table 6. Numbers of Pacific hake biological samples and measurements collected on the NOAA Ship *Miller Freeman* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

Haul	Length	Otoliths	Fish Weight	Maturity
1*	--	--	--	--
2	0	26	26	26
3	0	0	0	0
4	57	72	72	72
5*	--	--	--	--
6	312	73	73	73
7	39	66	68	68
8	37	57	57	57
9	373	82	82	82
Totals	818	376	378	378

*Hauls were unsuccessful.

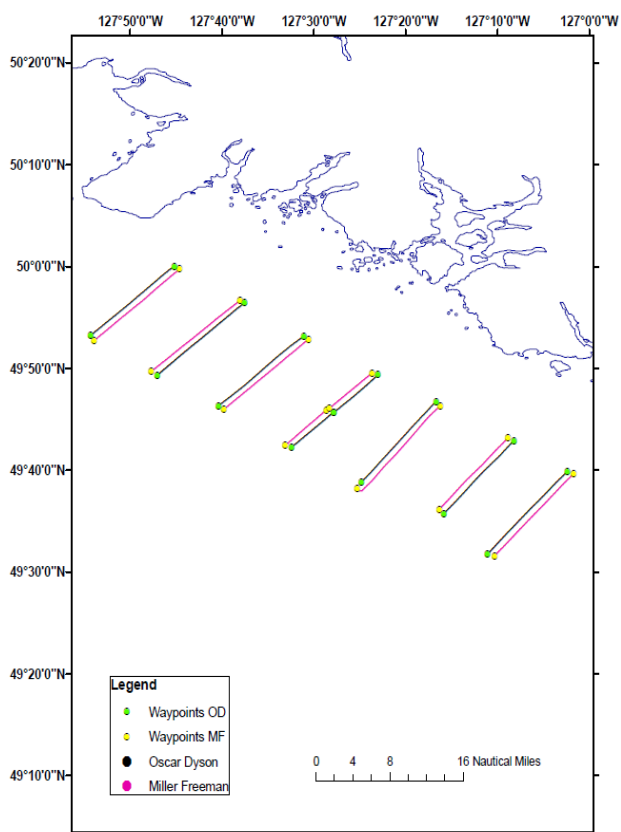
Table 7. Summary of conductivity-temperature-depth (CTD) casts conducted aboard the NOAA Ship *Miller Freeman* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Bottom Depth (m)
2	11 Aug	17:43	47	37.06	122	22.63	--
1	13 Aug	7:16	48	37.15	126	7.73	148
2	13 Aug	8:16	48	35.54	126	10.83	496
3	14 Aug	6:09	48	34.95	126	10.28	406
4	14 Aug	7:13	48	34.74	126	1.90	112
5	14 Aug	9:29	48	34.57	125	36.62	90
7	15 Aug	9:15	48	35.08	126	12.29	737
8	15 Aug	11:01	48	45.12	126	23.98	409
9	16 Aug	5:18	49	0.76	126	51.96	479
10	17 Aug	5:28	49	49.59	127	47.20	763
11	17 Aug	8:34	49	45.29	127	40.47	653
13	18 Aug	12:53	48	44.86	126	25.40	493
14	21 Aug	16:02	48	58.62	125	19.54	37
15	23 Aug	5:04	49	45.44	127	40.66	671
16	23 Aug	6:42	49	41.35	127	26.91	401
17	23 Aug	8:26	49	33.30	127	16.16	304
18	25 Aug	3:33	49	32.05	127	20.49	931
19	25 Aug	4:32	49	35.32	127	21.07	523
20	25 Aug	5:38	49	39.41	127	25.47	509
21	26 Aug	3:20	49	51.48	127	42.07	183
22	26 Aug	4:07	49	49.41	127	40.94	325
23	26 Aug	4:50	49	47.40	127	40.25	285

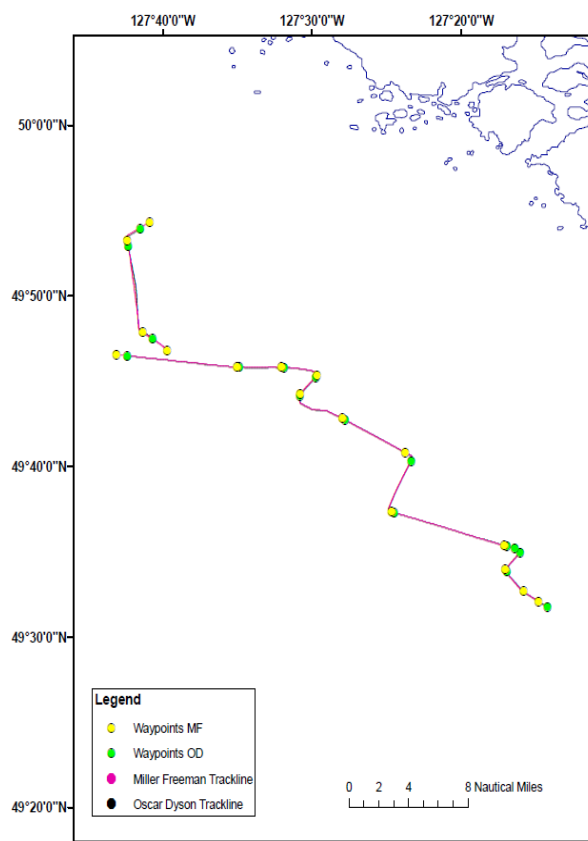
Table 8. Summary of conductivity-temperature-depth (CTD) casts conducted aboard the NOAA Ship *Oscar Dyson* during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

CTD Number	Date	Drop Time (GMT)	Latitude (°N)		Longitude (°W)		Bottom Depth (m)
1	10 Aug	19:55	47	37.37	122	24.09	53
2	10 Aug	20:00	47	37.37	122	24.09	53
3	11 Aug	13:10	47	37.37	122	24.08	53
4	13 Aug	5:01	48	36.31	125	3.12	89
5	13 Aug	6:13	48	36.22	125	15.64	118
6	13 Aug	7:29	48	36.13	125	28.67	172
7	13 Aug	9:44	48	36.09	126	0.16	118
8	13 Aug	10:38	48	36.34	126	6.68	151
9	15 Aug	12:45	49	54.22	127	47.22	190
10	16 Aug	22:05	49	41.79	127	34.17	464
11	17 Aug	11:20	49	41.70	127	26.93	250
12	17 Aug	12:57	49	33.45	127	15.73	177
13	21 Aug	16:20	48	57.52	125	20.32	--

Side-by-Side Transects 08/16/08



Follow-the-Leader Transect One 08/17/08



Follow-the-Leader Transect Two 08/17/08

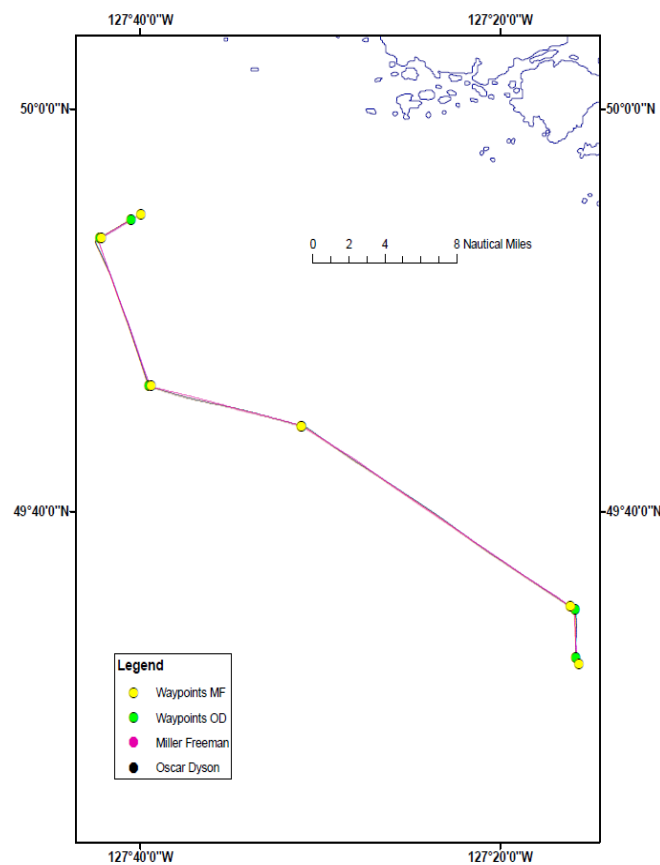


Figure 1. Cruise track design used during leg 1 of the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

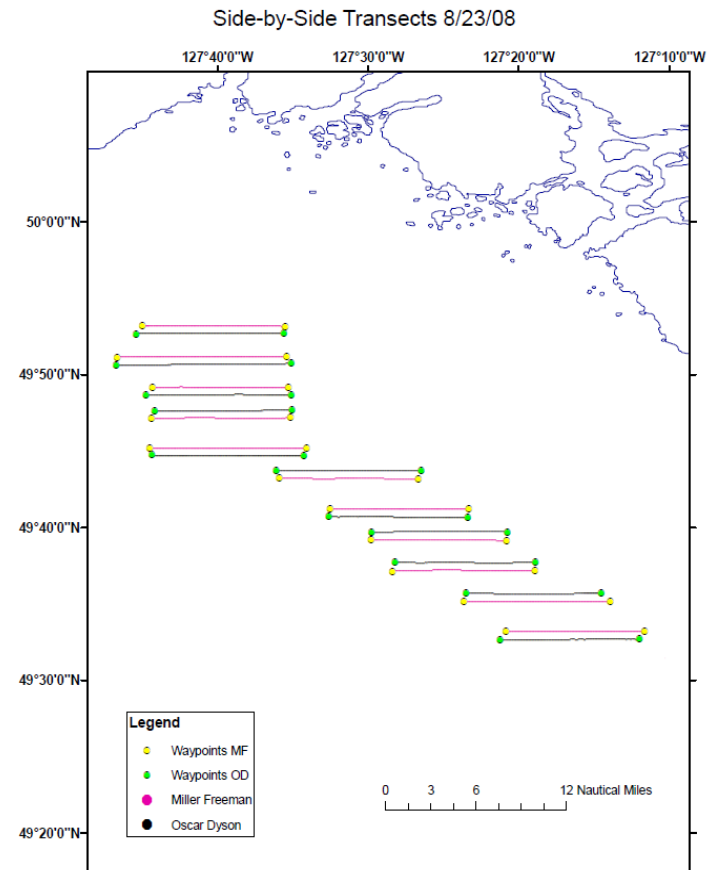
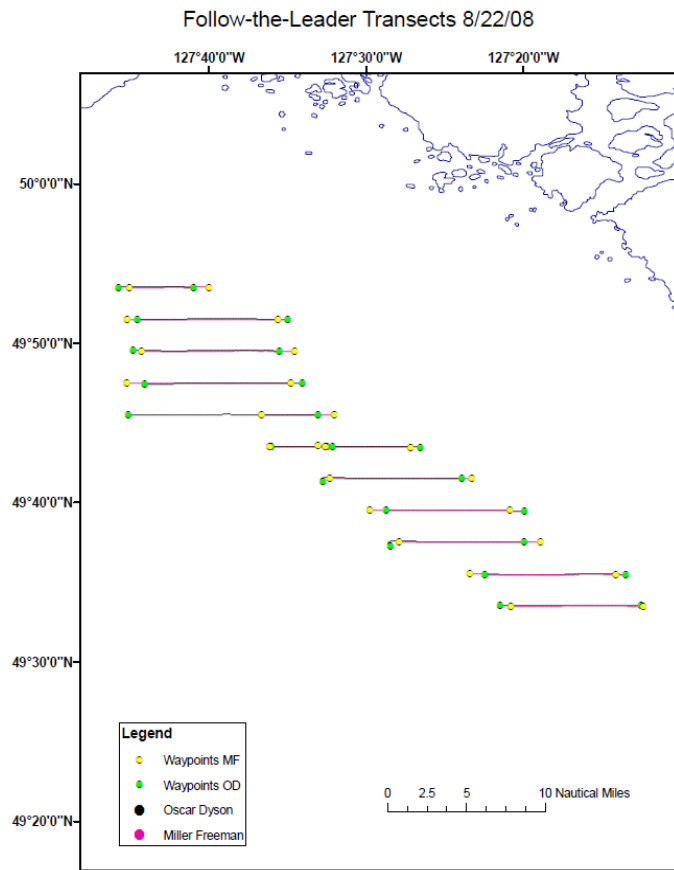


Figure 2. Cruise track design used during leg 2 of the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

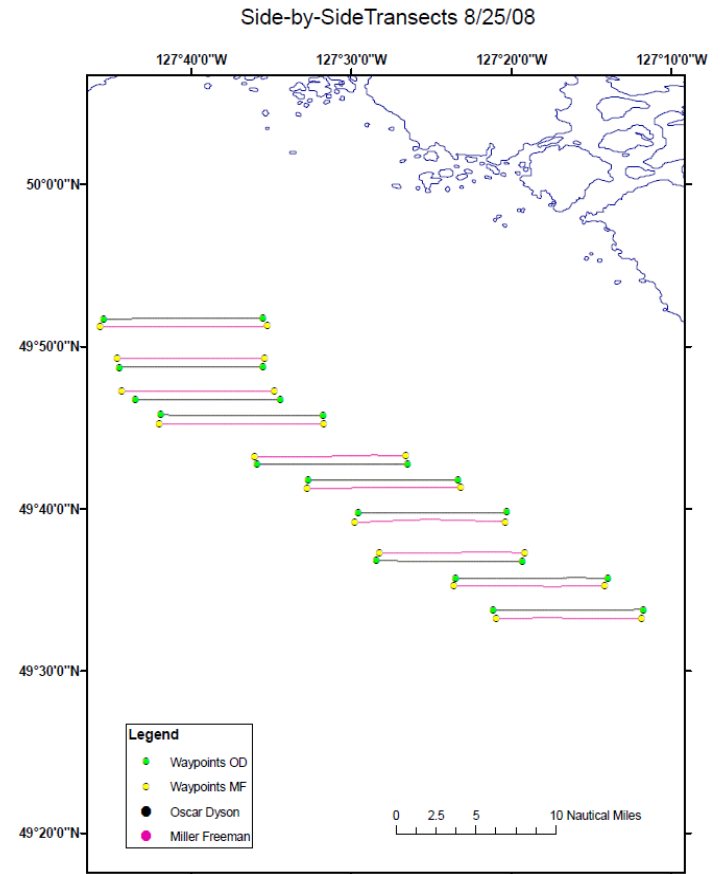
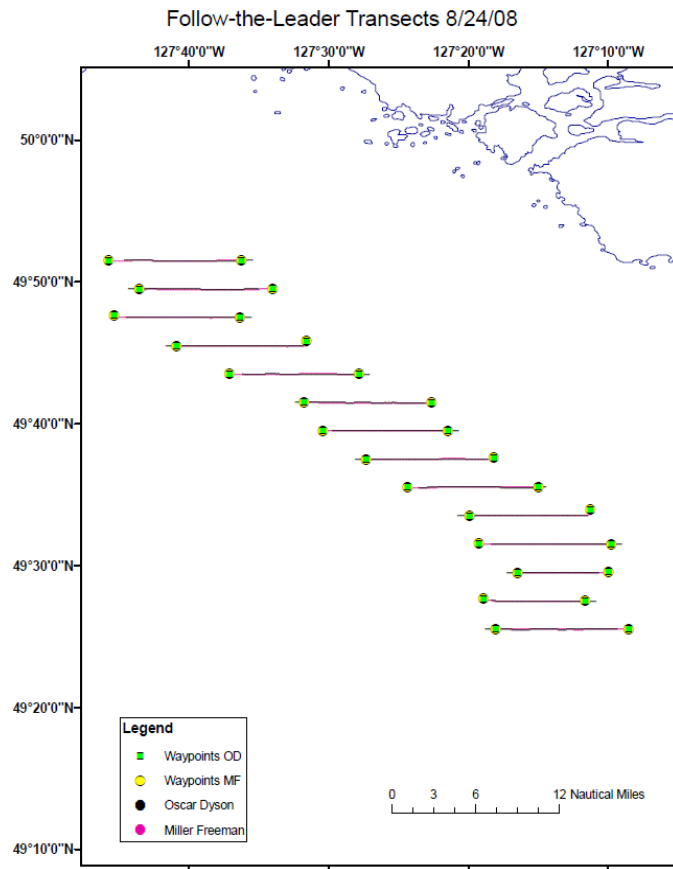
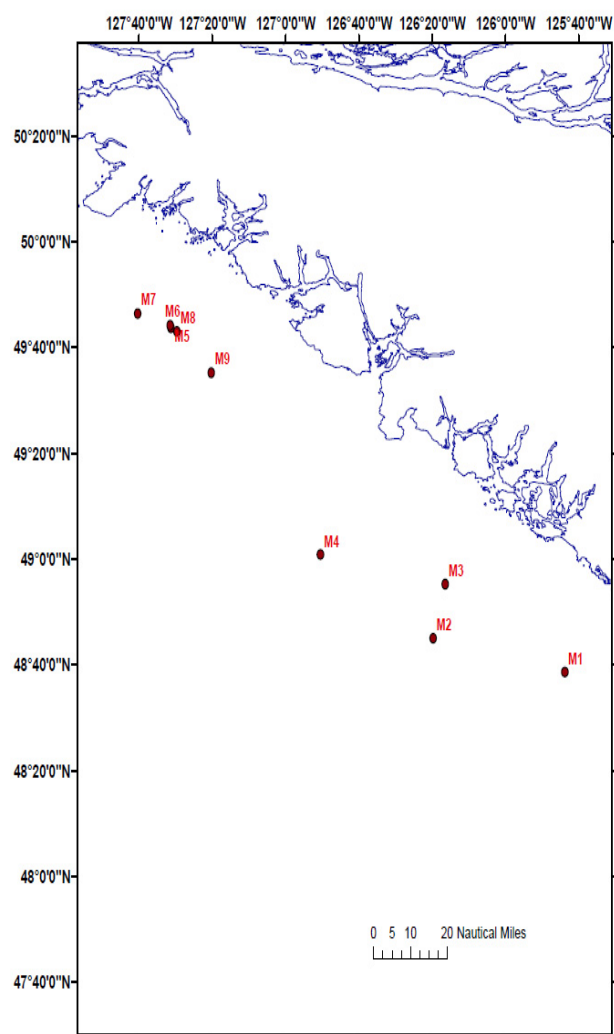
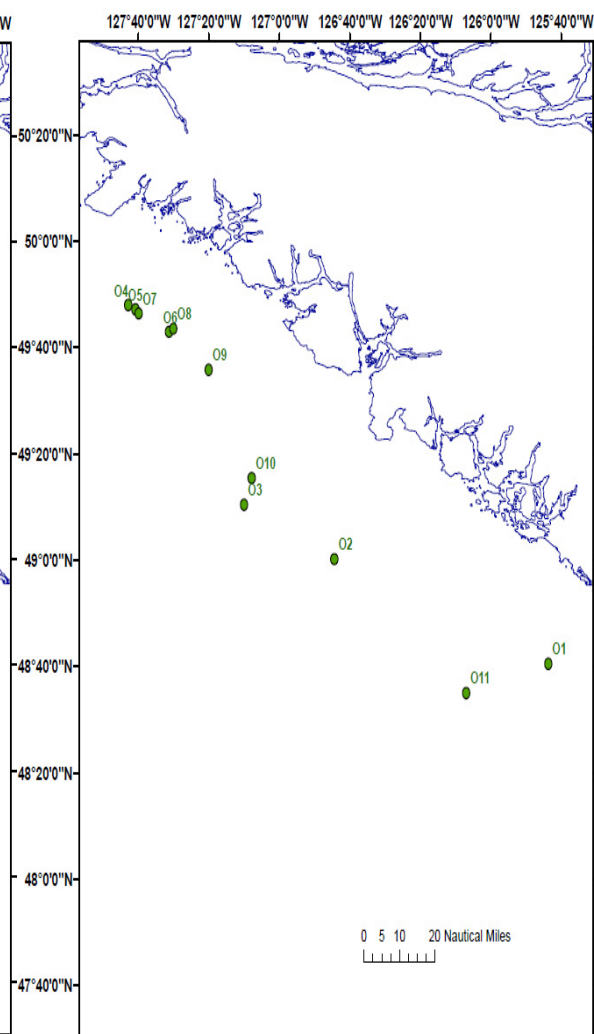


Figure 3. Cruise track design used during leg 2 of the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

2008 Hake IVC: Tows Miller Freeman



2008 Hake IVC: Tows Oscar Dyson



2008 Hake IVC: Tows W.E. Ricker

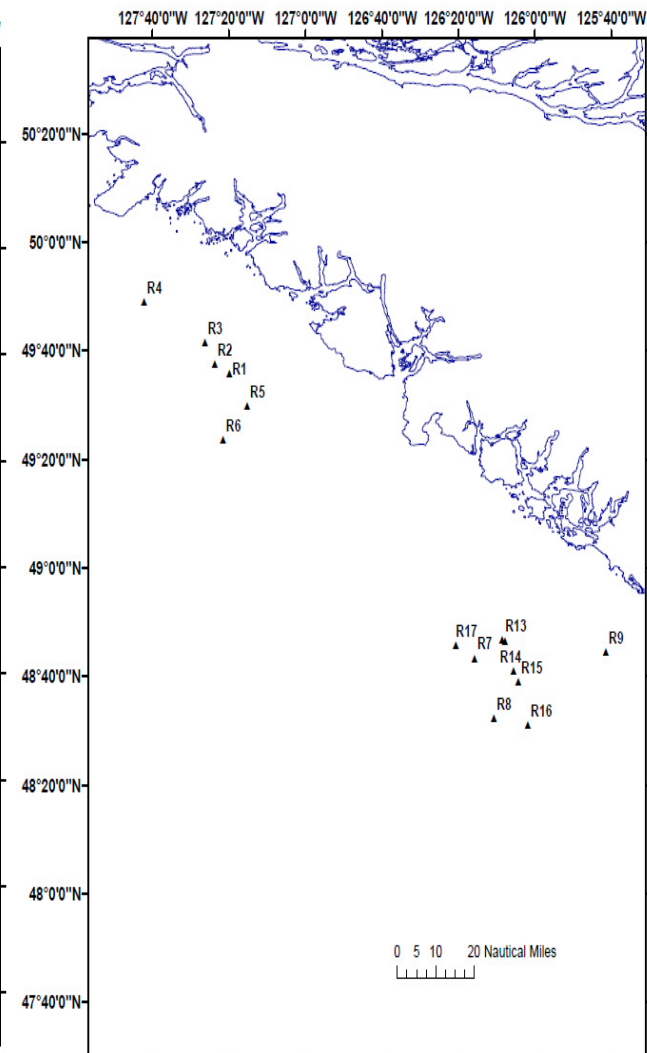


Figure 4. Haul sequence of trawls conducted during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada.

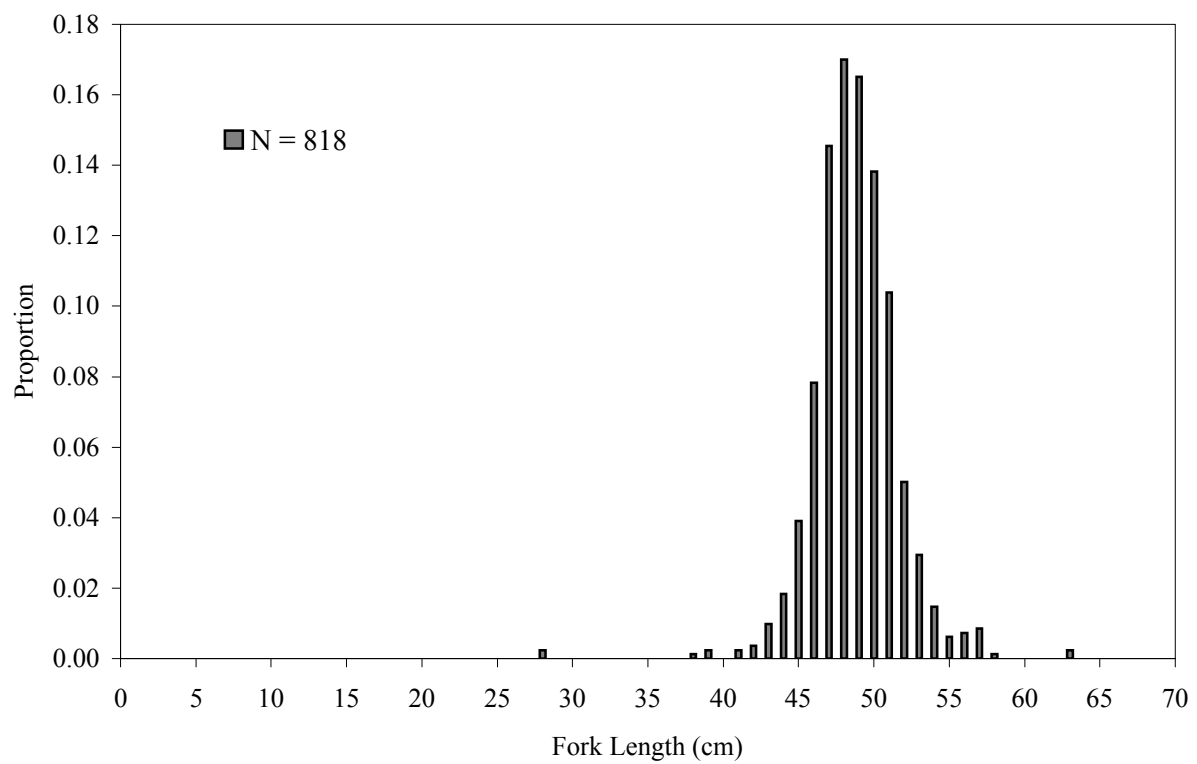


Figure 5. Length-frequency distribution of Pacific hake from specimens collected during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada

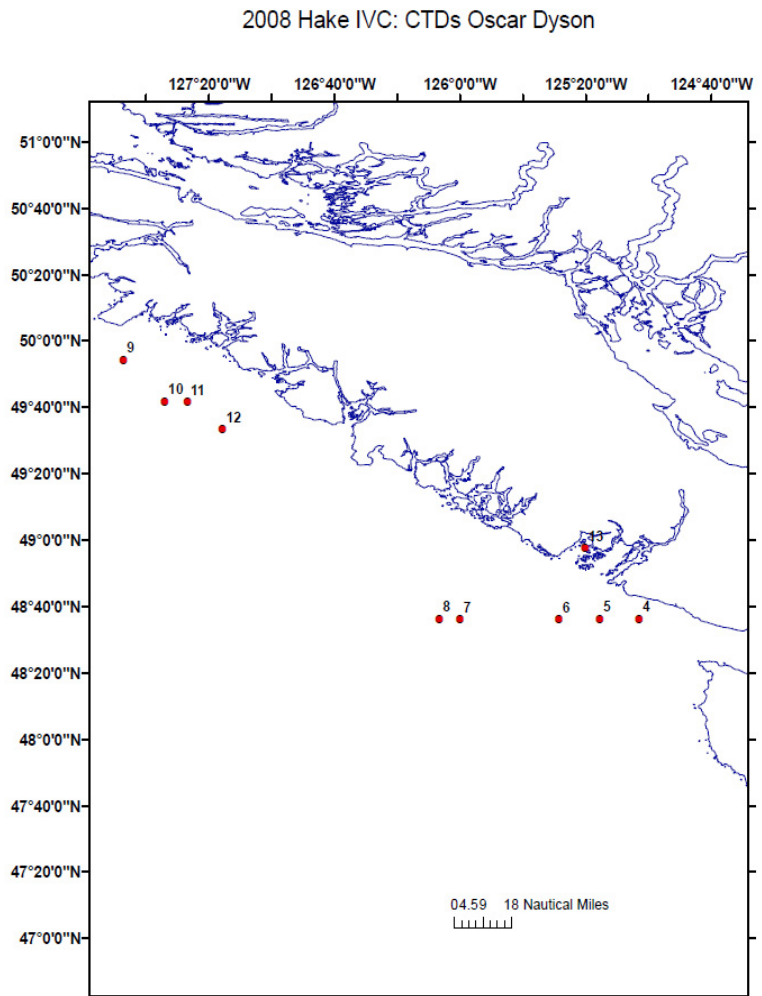
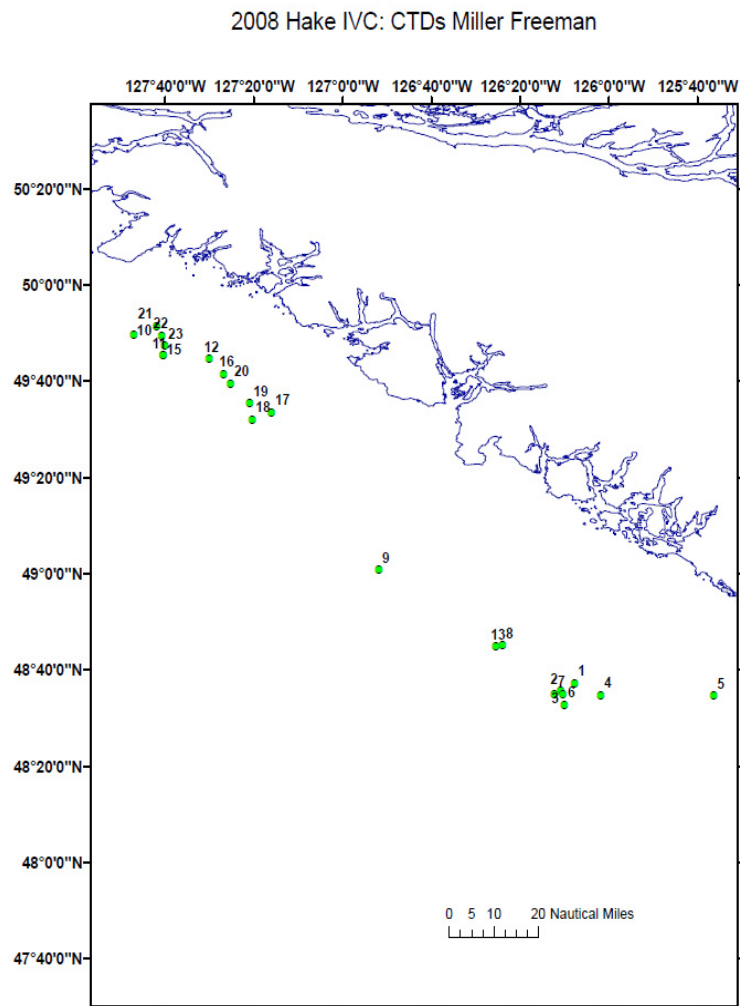


Figure 6. Locations of conductivity-temperature-depth (CTD) profile measurements taken during the 2008 Pacific hake inter-vessel calibration (IVC) off the west coast of Vancouver Island, Canada. Note: CTD's conducted during calibration of the acoustic system in Elliott Bay, WA are not included.